# POPULATION DYNAMICS OF HOUSE SHREW *SUNCUS MURINUS* IN RICE AND WHEAT FIELDS IN CENTRAL PUNJAB, PAKISTAN [1]

ABDUL RAUF KHOKHAR[2]

Population dynamics of the house shrew *Suncus murinus* in the wild in Pakistan is presented. Rice and wheat fields were kill trapped bimonthly from August 1977 to October 1978. There were significant variations in body weight, head and body length between specimens collected not only from different agro-ecological zones but also from the same area. Overall sex ratio of males and females did not deviate significantly from equality. However, males significantly outnumbered females in wet cropland of rice. Insect diet and reproduction greatly influenced the movements and density of shrews in rice and wheat fields. Pregnancy rate remained low in rice fields and high in wheat fields. Breeding stopped in winter. Litter size averaged 4.17 ± 0.38 (range = 2-6).

## INTRODUCTION

The house shrew *Suncus murinus* is a well known, small mammal with a wide distribution (Roberts 1977, Brooks *et al.* 1980). The significance of this species has only recently been recognised from the health point of view because of its reported association with plague in urban areas of Burma, Vietnam and Taiwan (Brooks *et al.* 1980).

The information presented here on shrews was collected incidentally during a study on the biology of rodents of rice and wheat fields.

## METHODS

The study was undertaken in Sheikhupura district (31°47′ N, 74°15′ E) along the Lahore-Sheikhupura road, 16-26 km west of Lahore. Data were gathered on shrews collected through snap traps baited with *chapati* (wheat flour pancake) and set in pairs 10-15 paces apart with 50 traps per trap line along the edge, 2-4 m into the crop fields. Two or four trap lines were operated simultaneously.

Rice crop is transplanted from nursery beds in June-July and harvested in October-November. Rice fields after harvest usually remain unploughed with stubble and many scattered piles of sheaves until December, when the fields are prepared for the wheat crop. Wheat is sown in November-December and harvested in April-May. July, August and September are the monsoon months.

Trapping was undertaken every two months from August 1977 to October 1978 in the regular study areas. Traps were set in the evening and checked in the morning typically for four consecutive days. New farms were selected for each bimonthly sample except August and October, which were sampled twice in 1977 and 1978. The yearwise sample were not large enough to permit comparison. Data for two years were pooled in the analysis.

**Collection:** Animals were collected from three trapping programmes: 1. A regular bimonthly trapping. 2. A kill trap survey of Punjab rice fields conducted by the personnel of Vertebrate Pest Control Laboratory in August 1977. 3. Punjab rice rat control trials conducted by the staff of the VPCL in 1977. Data gathered only from regular trapping sites were included in the determination of trap success, while the information on reproduction and diet was based on the animals received from other sources as well.

The trap success (Number of shrews x 100) ÷ (Number of trap nights) was used as an index of density. The body weight (BW), head and body length (HBL) were recorded only for a part of the collection. Shrews were sexed, weighed, measured and dissected within an hour after collection. Pesola spring balance was used for measuring BW. Reproductive conditions such as

[1]Accepted November 1990

[2]Vertebrate Pest Control Laboratory, University Campus, Pest Management Research Centre, Pakistan Agricultural Research Council, P.O. Box 8401, Karachi 32, Pakistan.

lactation, embryo count, scar count, nulliparous or estrous condition were noted in all females trapped. In males, testes were observed for spermatogenic tubules in the cauda epididymis for fertility. Stomach contents of the shrews were microscopically analysed following Fulk *et al.* (1981).

## Results

**Sexual dimorphism:** Table 1 shows HBL and BW of *S. murinus*. There was a significant difference in BW in all body lengths exceeding 129 mm ($P < 0.05$). Males predominated in the largest length classes.

**Males:** Rodent criteria of the position of testes as scrotal or abdominal could not be used to distinguish mature males from the immature ones.

Testes in *S. murinus* are retained permanently in the posterior position of coelomic cavity in a shallow pouch called cremaster sac (Deshpande 1959). They do not descend into a scrotum in fertile males as generally is the case in rodents. Male maturity, therefore, could only be distinguished internally by the presence or absence of spermatogenic tubules in the cauda epididymis. Moreover, testes in mature males were somewhat greenish in colour while pale in immature ones.

Overall, males had an average BW of 52.6 ± 1.26 (SE) g (range=28-82) and HBL 138.1 ± 1.5 (SE) mm (range = 101-175 mm). The average weight of mature males (with visible tubules) was 57.3 ± 1.3 (SE) g (range = 38-78) and HBL 143.2 ± 1.5 (SE) mm (range = 120-161). The average BW of immature males was 42.4 ± 2.8 (SE) g (range = 15-58) and HBL 132.4 ± 2.5 (SE) mm (range = 115-154). Mature males weighed significantly more than immature ones ($t = 4.83$; $df = 72$; $P < 0.001$). The HBL of mature males was also significantly greater than that of immature ones ($t = 3.71$; $df = 69$; $P < 0.001$).

**Females:** Rodent criteria of opening of vaginal orifice could not be used for separating mature female shrews from immature ones because the orifice is concealed in the cloaca. The attainment of reproductive maturity was judged only by examining the state of uterus (pregnant, scars or estrous).

The average BW of females was 37.4 ± 0.9 (SE) g (range = 24-58) and HBL 122.8 ± 1.57 (SE) mm (range = 89-150). The average BW of mature females was 41.4 ± 1.49 (SE) g (range = 24-58 and HBL 129.1 ± 2.58 (SE) mm (range = 107-138).

The average BW of mature but non pregnant females was 43.2 ± 1.79 (SE) g (range = 24-54) and HBL 134.3 ± 3.09 (SE) mm (range = 109-154). The average BW of immature females was 34.0 ± 1.15 (SE) g (range = 24-46) and HBL 121.9 ± 2.04 (SE) mm (range = 109-141). The average BW of mature females was significantly greater than that of immature ones ($t = 4.32$; $df = 57$; $P < 0.001$). The average HBL of mature females was also significantly greater than that of immature ones ($t = 3.35$; $df = 55$; $P < 0.005$).

**Density**: During the rice season, the shrew density was low in August but increased as harvest ap-

Table 1
MEAN BODY WEIGHT AND BODY LENGTH IN *Suncus murinus* FROM PUNJAB

| Head & body length classes | Body weight (g)* Males | Females | Probability of difference |
|---|---|---|---|
| 89–98 | – | (1) 30.0 | – |
| 99–108 | (1) 38.0 | (4) 30± 4.0 | – |
| 109–118 | (2) 40 ± 10 | (15) 34.4± 5.9 | N S |
| 119–128 | (13)42.4 ± 9.3 | (20) 37.9 ± 6.4 | N S |
| 129–138 | (24)48.8 ± 10.2 | (9) 44.1± 4.5 | P < 0.05 |
| 139–148 | (18) 56.3 ± 5.2 | (3) 47.3 ± 7.7 | P < 0.05 |
| 149–158 | (10) 65 ± 10.9 | (3) 45.5± 8.5 | P < 0.05 |
| 159–168 | (3) 68 ± 4.2 | – | – |

*Body weights were taken only of those specimens whose measurements were also taken.
Numbers in parentheses indicate number of specimens examined.

TABLE 2
SEX RATIOS OF *Suncus murinus* IN WET AND DRY CROPLAND

| Sex | Wet | Dry | Total |
|---|---|---|---|
| Male | 56 | 26 | 82 |
| Female | 35 | 34 | 69 |
| Total | 91 | 60 | 151 |

TABLE 3
TRAP SUCCESS AND REPRODUCTIVE PATTERN OF *Suncus murinus* IN RICE AND WHEAT FIELDS

| Month | Crop | Trap nights | Trap success | Males % tubules visible | Females % pregnant | Mean litter size |
|---|---|---|---|---|---|---|
| August | Rice (vegetative) | 690 | 1.3 | 81 (16) | 37.5 (8) | 3.7 |
| October | Rice (harvest) | 1169 | 3.2 | 62 (34) | 28.6 (21) | 4.0 |
| December | Rice (unploughed fields) | 750 | 6.8 | – | – | – |
| February | Wheat (flowering) | 712 | 0.7 | 0 (2) | 0 (3) | – |
| April | Wheat (harvest) | 699 | 0.4 | 100 (1) | 100 (2) | 4.0 |
| June | Wheat (fallow fields) | 740 | 0.8 | 75 (74) | 100 (2) | 5.5 |

Sample sizes are given in parentheses.

proached (Table 3). The density was highest in the unploughed post harvest rice fields in December when the fields were devoid of any vegetational cover except rice stubble. After a peak in December, the shrew density again declined sharply during the flowering stage of wheat (February) and remained low in the harvest and post harvest stage of the crop, i.e. April and June (hot months).

**Diet:** The diet of shrews contained 4% rice and 16% wheat during the months of rice and wheat ripening Insects accounted for over 70% of the diet in all months except February and April, when insect consumption fell to 63 and 44%, respectively.

## REPRODUCTION

**Sex ratio:** The ratio of males to females was 1 : 0.8 which did not deviate significantly from unity ($\chi^2 = 1.1$; $P < 0.25$). Males, however, significantly outnumbered females (Table 2) in wet fields of rice crop, $\chi^2$ 4.84; $P<05$).

**Male fertility:** The number of fertile males remained high in all months, though at lower proportions during October and February when the overall pregnancy rates were also low (Table 3).

**Pregnancy rates:** Pregnancy rates as determined from embryo count were low from August to October in the irrigated rice fields and high from April to June in the dry wheat fields (Fig.1, Table 3) with no breeding in cold months (February). Data could not be recorded in December. Anyhow, Beg *et al.* (1986) report that *S. murinus* ceases to breed in the Punjab in the cold months of December and January.

**Litter size:** Litter size averaged 4.17 ± 0.38 (range = 2-6).

TABLE 4
WEIGHTS AND MEASUREMENTS OF *Suncus murinus* (mean ± SE)
AT FAISALABAD* AND SHEIKHUPURA

| Type | N | Weight (g) | Body length |
|---|---|---|---|
| **Males** | | | |
| Faisalabad (F) | 26 | 57.5 ± 1.99[a] | 148 ± 1.82 [b] |
| Sheikhupura (S) | 82 | 52.6 ± 1.26 | 138.1 ± 1.52 |
| **Females** | | | |
| Faisalabad (F) | 50 | 41.3 ± 1.54[a] | 132 ± 1.68[b] |
| Sheikhupura (S) | 69 | 37.5 ± 0.9 | 122.8 ± 1.57 |

a = Significantly greater than S at P <0.025 by Student's t-test. b = Significantly greater than S at P <001 by Student's t-test.
* Faisalabad data were taken from Beg *et al.* (1986).

## DISCUSSION

Extreme variations in adult weight of this species from various geographic localities have been reported by several authors (Brooks *et al.* 1980, Rana and Prakash 1979, Hasler *et al.* 1977, Louch *et al.* 1966, Barbehenn 1962, Harrison 1955).

The heaviest *S. murinus* were reported from Calcutta by Louch *et al.* (1966) who found that male (N=75) and female (N = 92) shrews averaged 105.6 g and 67.6 g respectively. The smallest *S. murinus* was recorded from Guam by Barbehenn (1962), who noted the average weight of males to be 30 g and that of females 21 g. Dryden's (1968) figure is still lower — 1.8 g. Harrison (1955) found weights of 55 g and 45 g for male and female Malaysian *S. murinus*, respectively. The weights of male and female shrews in the present study area are quite close to those of Malaysian shrews but considerably less than those of Calcutta.

Uptill now several workers have recorded significant variations in adult BW and HBL of *S. murinus* trapped from different geographical localities. However, comparison of data from Sheikhupura and Faisalabad districts of Punjab collected respectively during the present study and by Beg *et al.* (1986) suggested that even shrews living in the same locality showed significant variations in BW and HBL (Table 4). The BW and HBL of male shrews in Faisalabad (F) were significantly greater than those of Sheikhupura (S) male shrews ($t = 2.07$; $df = 142$; $P < 0.025$ and $t = 4.15$; $df = 142$; $P < 0.001$, respectively). Similarly, F-females were also significantly heavier and longer than S-females ($t = 2.13$; $df = 117$; $P < 0.025$ and $t = 4.00$; $df = 117$; $P < 0.001$, respectively).

Various parameters of shrew population in rice and wheat fields were influenced by environmental changes in the surrounding habitat. Low shrew density in the flooded rice fields in August in spite of high (100%) pregnancy rates in the preceding dry months and abundant (71.9%) insect diet in this month could be related to the possibility that excessive water in rice fields was unfavourable for the survival of shrews.

The peak density in the cold month (December) in fallow and uncovered dry rice fields seemed to be linked with the immigration of shrews from the surrounding area and not with the recruitment of young as the reproductive rate was low (28.6%) in the previous months (Table 3).

This seemed possible as the insects which are one of major determinants of shrew density (Smiet *et al.* 1980) were the main (81.4%) food items in the diet. In Punjab, the larvae of rice insect pests generally overwinter in the stubble during cold months (Choudhry *et al.* 1983). Therefore, immigration of shrews into rice fields might have been due to the presence of these larvae.

After rice harvest harvest, the crash in the shrew density in February, which persisted up to April in wheat fields, could be related to winter quiescence in reproduction in the current and preceding months. Moreover, the insect diet also fell (63 and 44%) during these months. The second peak (though small) in fallow wheat fields

TABLE 5
REPRODUCTIVE PROFILE OF *Suncus murinus* AT SIX PLACES

| Place/Author | Weight of Female (g) | Litter size | Breeding |
|---|---|---|---|
| Guam<br>Barbehen (1962) | 21.0 | 2.1 ± 0.10 | Throughout the year |
| Malaysia<br>Harrison (1955) | 45.0 | 2.7 ± 0.14 | Throughout the year |
| Rangoon<br>Brooks *et al.* (1980) | 41.6 | 2.99 ± 1.21 | Throughout the year |
| Calcutta<br>Louch *et al.* (1966) | 67.7 | 3.8 ± 0.28 | Throughout the year |
| Rajasthan desert<br>Rana & Prakash (1979) | 23.5 | 4.71 ± 0.23 | September to March<br>No breeding from<br>October to February |
| Punjab<br>Present study | 37.5 | 4.17 ± 0.39 | April to October.<br>No breeding in winter<br>(February) |

in June followed the month (April) of high (100%) reproduction. Moreover, high (95%) frequency of insect diet available in June also seemed to be responsible for this peak.

Although data on pregnancy rates in *S. murinus* is small, a clear cut reproductive pattern did emerge from this study. The breeding data presented here are not incompatible with that observed in *S. murinus* in Rangoon, Calcutta, Guam and Malaysia (Brooks *et al.* 1980, Louch *et al.* 1966, Barbehenn, 1962, Harrison 1955). At all these places the peak in reproductive activity occurred in the dry season and declined during rainy season. In Punjab, the peak in pregnancies also occurred in dry wheat fields from April through June and then reduced in inundated rice fields (with water overflowing the bunds) in August and remained so up to October. This low breeding activity suggested that rice field environments adversely effect breeding in this species. Conversely, highest breeding was recorded in *S. murinus* during monsoon in the Rajasthan desert by Rana and Prakash (1979) and in indoor populations by Brooks *et al.* (1980) and Beg *et al.* (1986). At all these places the negative effect of rainfall on breeding obviously did not exist.

Increase in litter size has been reported to occur with increase in body weight in *Suncus* (Table 5). This criteria, however, does not hold good with the shrew population in Rajasthan and Punjab, where females, though lighter (23.5 and 37.5 g) than at other places, still produce significantly larger litters of 4.71 ± 1.23 and 4.17 ± 0.39 respectively. The female at these places stops reproduction during winter months as against those which continue breeding throughout the year. The larger litter size in Punjab and Rajasthan population in a way may be a compensation for winter cessation of breeding so as to maintain a higher yearly turnover rate of the population (Rana and Prakash 1979, Beg *et al.* 1986).

## REFERENCES

BARBEHENN, K.R. (1962): The house shrews on Guam. *In:* Pacific Island Rat Ecology. Ed. T.I. Storer, Bishop Mus. pp. 225, 247-256.

BEG, M.A., KAUSAR, S., HASSAN, M.M. & KHAN, A.A. (1986): Some demographic and reproductive parameters of the house shrews in Punjab, Pakistan. *Pak. J. Zool. 18 (2):* 201-208.

BROOKS, J.E., HTUN, P.T., WALTON, D.W., NAING, H.& TUN, M.M. (1980): Reproductive biology of *Suncus murinus* L. in Rangoon, Burma. *Z. Saugetierkunde 45:* 12-22.

CHOUDHRY, N.A., RAZZAQ, M.A. & MASOOD, I. (1983): Population dynamics of rice stem borers on light traps in rice growing areas of Punjab. Proc. Fourth National Seminar on Rice Research and Production, 1983. Pakistan Agricultural Research Council, Islamabad. pp. 268-273.

DESHPANDE, K.S. (1959): Morphology of the male reproductive system in the shrew, *Suncus murinus* Linn. (Insectivora, Soricidae). *Bull. Zool. Soc. Coll. Sci.* (Nagpur) *2:* 1-9.

DRYDEN, G.L. (1968): Growth and development of *Suncus murinus* in captivity in Guam. *J. Mammology 49:* 51-61.

FULK, G.W., LATHIYA, S.B. & KHOKHAR, A.R. (1981): Rice rats of lower Sind: abundance, reproduction and diet. *J. Zool. London. 193:* 370-390.

HARRISON, J.I. (1955): Data on the reproduction of some Malayan mammals. *Proc. Zool Soc. London 125:* 445-460.

HASLER, M.J., HASLER, J.F. & NALBANDOV, A.V. (1977): Comparative breeding biology of musk shrew *Suncus murinus* from Guam and Madagascar. *J. Mammology 58:* 285-290.

LOUCH, C.D., GHOSH, A.K. & PAL, B.C. (1966): Seasonal changes in weight and reproductive activity of *Suncus murinus* in West Bengal, India. *J. Mammology 47: 73-78.*

RANA, B.D. & PRAKASH, I. (1979): Reproductive biology and population structure of the house shrew, *Suncus murinus sindensis* in Western Rajasthan. *Z. Saugetierkunde 44:* 333-343.

ROBERTS, T.J. (1977): The mammals of Pakistan. Ernest Benn. Limited, London.

SMIET, A.C., FULK, G.W., & LATHIYA, S.B. (1980): Rodent ecology in sugarcane in lower Sind, Pakistan. *Acta. Theriol. 25(8):* 79-81.